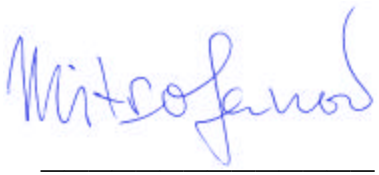
Information Package
for
Dynamic Albedo of Neutrons (DAN) Facility
for
NASA *Mars Science Laboratory* (MSL)

Edition 1



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DAN PI
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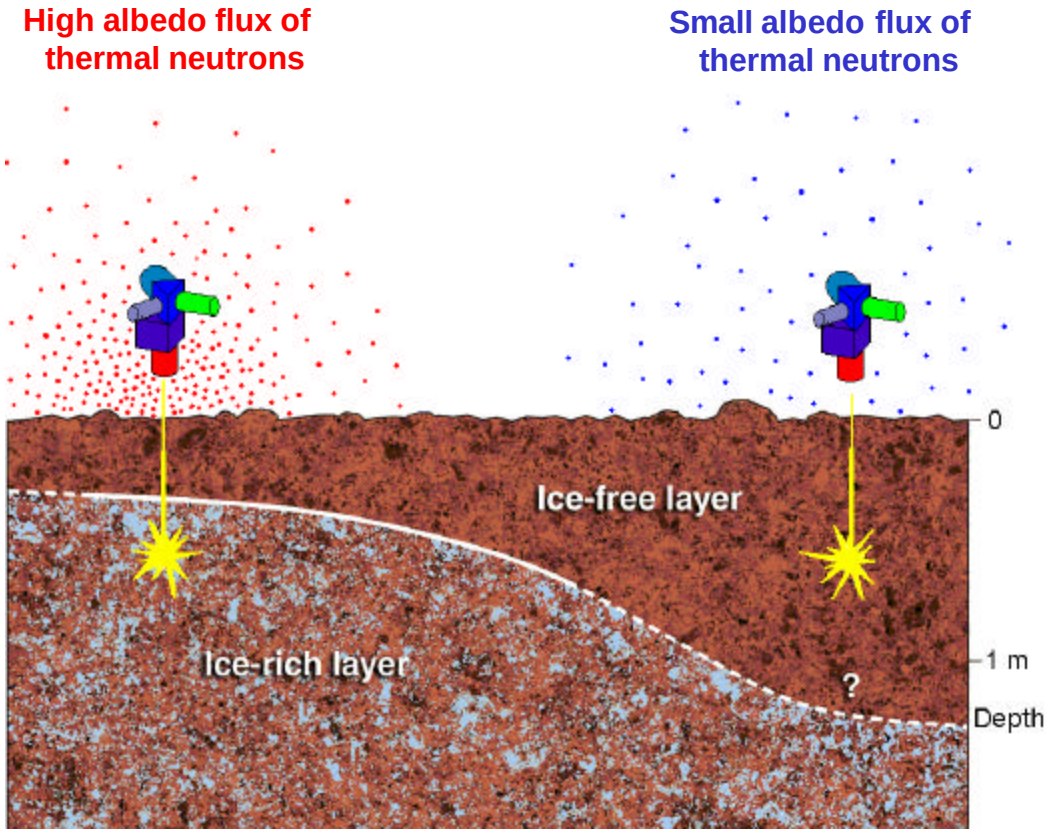
Physical concept of detection of subsurface water by albedo neutrons from the surface-based mobile laboratory

DAN has Pulsing Neutron Generator (PNG), which generate pulses of 14 MeV neutrons above the surface of Mars.

These neutrons are moderated within 1-2 meters of subsurface. Fluxes of secondary thermal neutrons are larger above ice-rich layer.

DAN has detectors of thermal neutrons, DTN and DETN, which record dynamic albedo of neutrons after pulses from PNG along the trace of MSL



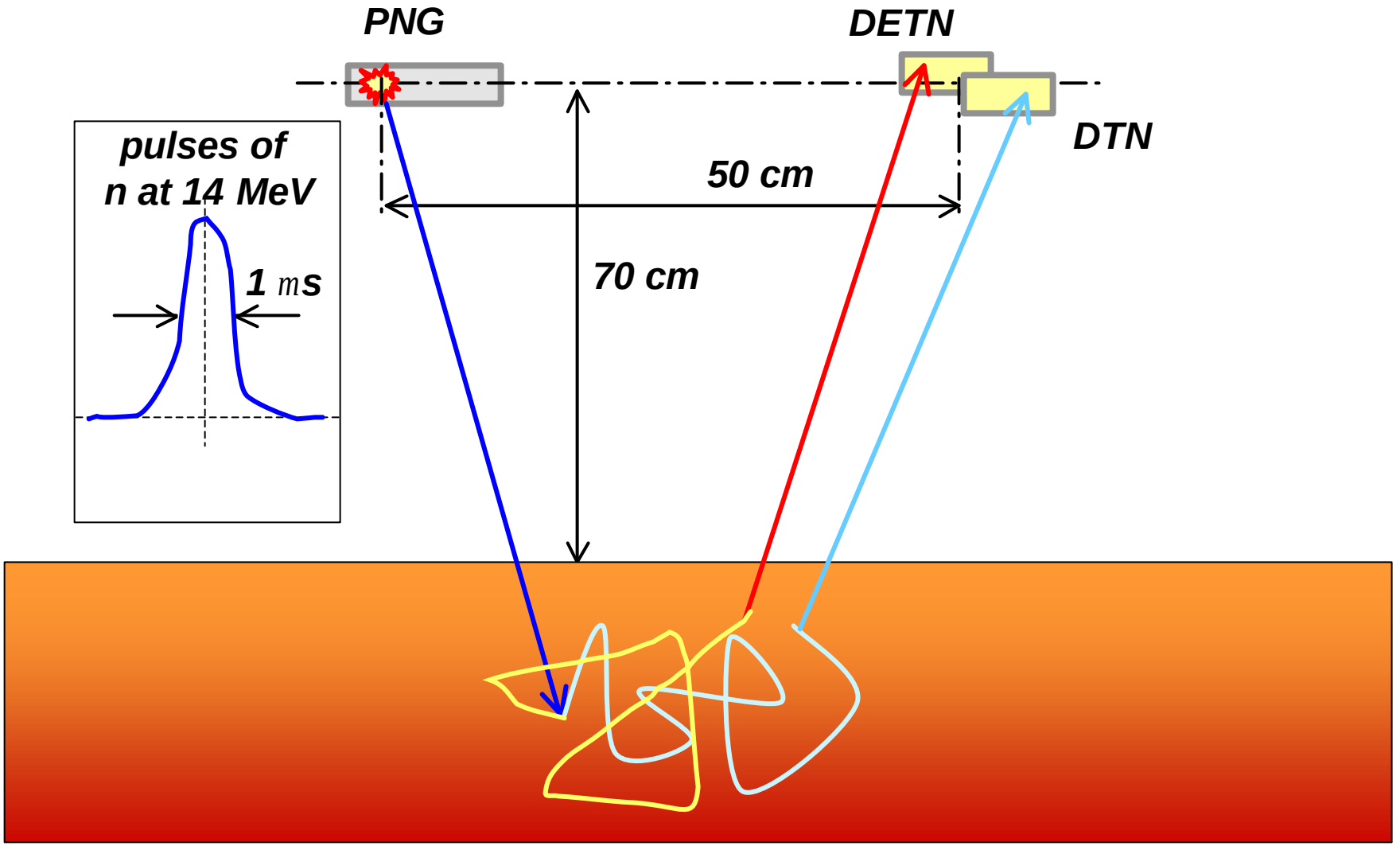
Primary Scientific Objectives of DAN are

To perform *in situ* analysis of hydrogen content of the bulk subsurface within a top 1 meter of subsurface (likely manifested as water or OH) with horizontal resolution of 30-100 cm along the trace of MSL.

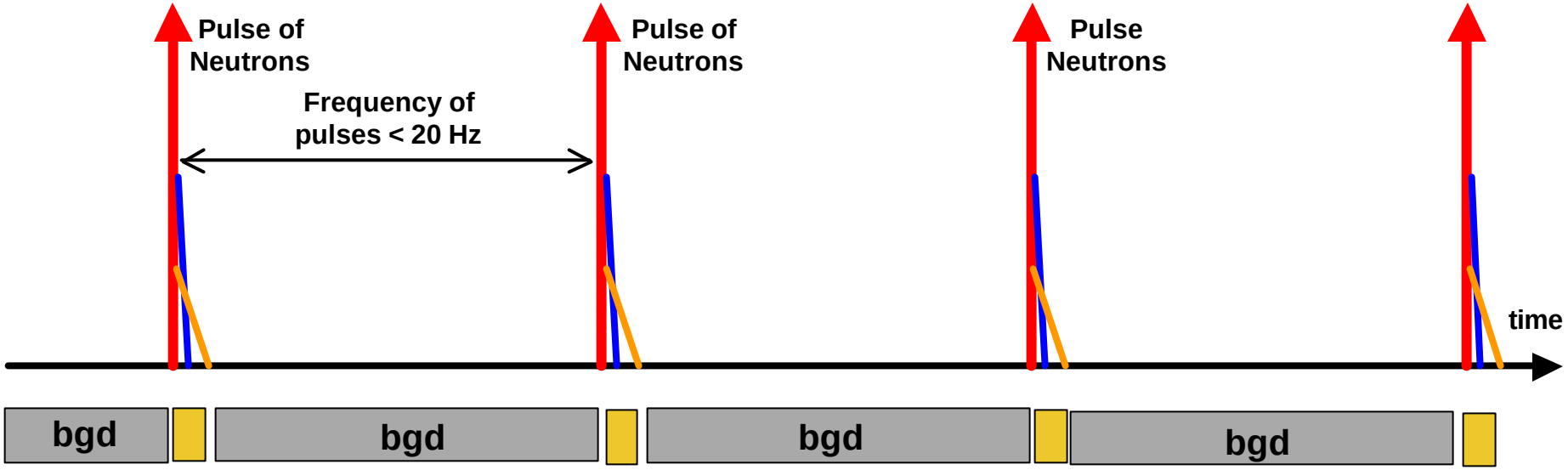
To perform *in situ* analysis of layering structure of hydrogen-bearing minerals or water in the subsurface with horizontal resolution of 30-100 cm along the trace of MSL.

Key measurements are:

Detection of thermal and epithermal *dynamical albedo of neutrons* with high time resolution, which are induced in the soil by Pulsing Neutron Generator


PNG
DETN
DTN
pulses of
n at 14 MeV
1 ms
50 cm
70 cm

The concept of measurements of albedo neutrons induced by Neutron Generator

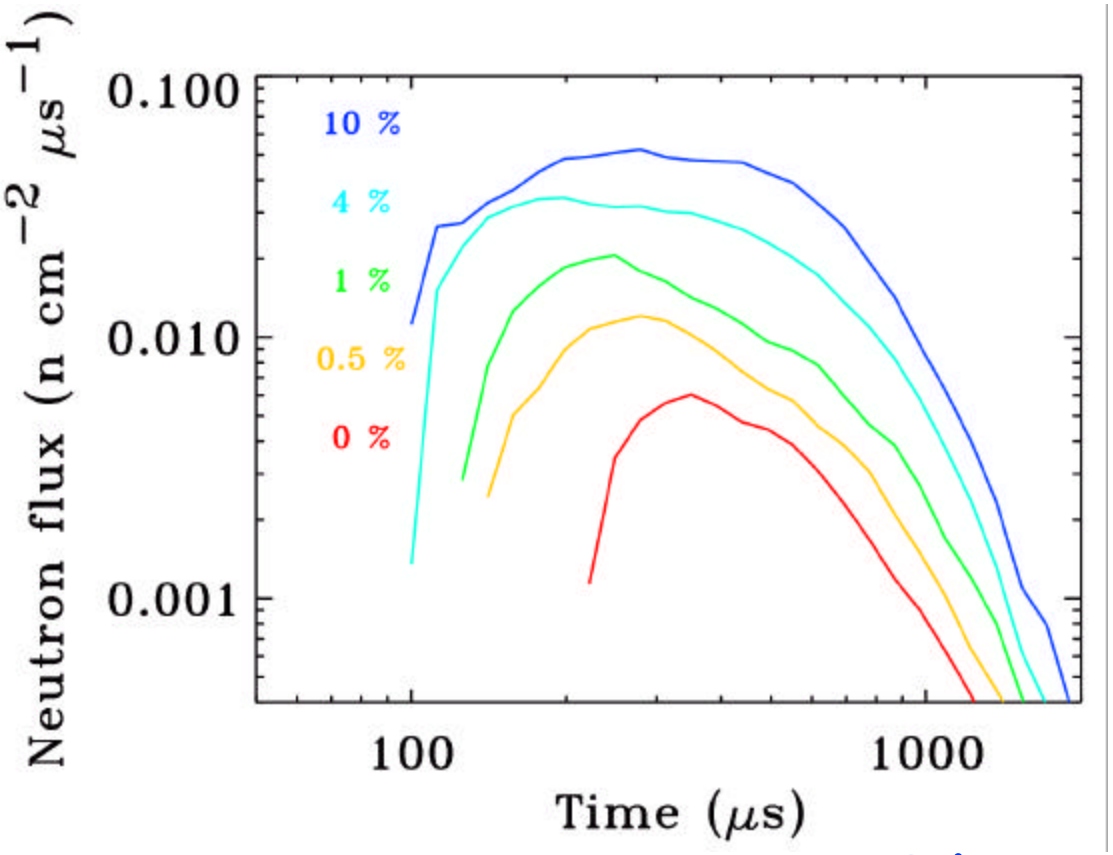


Neutron Generator produces 1 ms pulses of 10^7 neutrons at energy around 14 MeV (red arrows).

Each pulse of NG in synchronized with DAN measurements of neutrons albedo emission during "slowing-down-time" (yellow intervals), which is about 300 ms for epithermal neutrons and about 3 ms for thermal neutrons.

During time between pulses DAN measures background (gray intervals).

Time profiles of dynamic albedo of thermal neutrons are shown after pulse of DAN Pulsing Neutron Generator with 10^7 neutrons at pulse and pulse frequency 20 Hz for different wt% of water in the soil with Pathfinder composition



The sensitivity of Detector of Albedo Neutrons DAN for *in situ* analysis of soil moisture

Estimated counts rate (cts/s) of induced thermal neutrons for small neutron sensors with effective area = 1 cm^2 at expected distance from Neutron Generator with 10^7 neutron in one pulse and frequency of pulses equal to 20 Hz for different content of water (weight fraction in %). For more detail information see figure 1.

	No water	0.1%	1.0%	10%
Detector at 50 cm from Neutron Generator and 70 cm above martian surface	2.5	2.8	8	29

Estimated exposure time for detection of different content of water for Detector at 50 cm from Neutron Generator (10^7 neutron in one pulse and frequency of pulses equal to 20 Hz) and 70 cm above martian surface. Detection of water was based on 3s acceptance level. For more detail information see figure 2.

0.1%	1.0%	10%
600 sec	3 sec	0.4 sec

The sensitivity of Detector of Albedo Neutrons DAN for *in situ* analysis of soil moisture

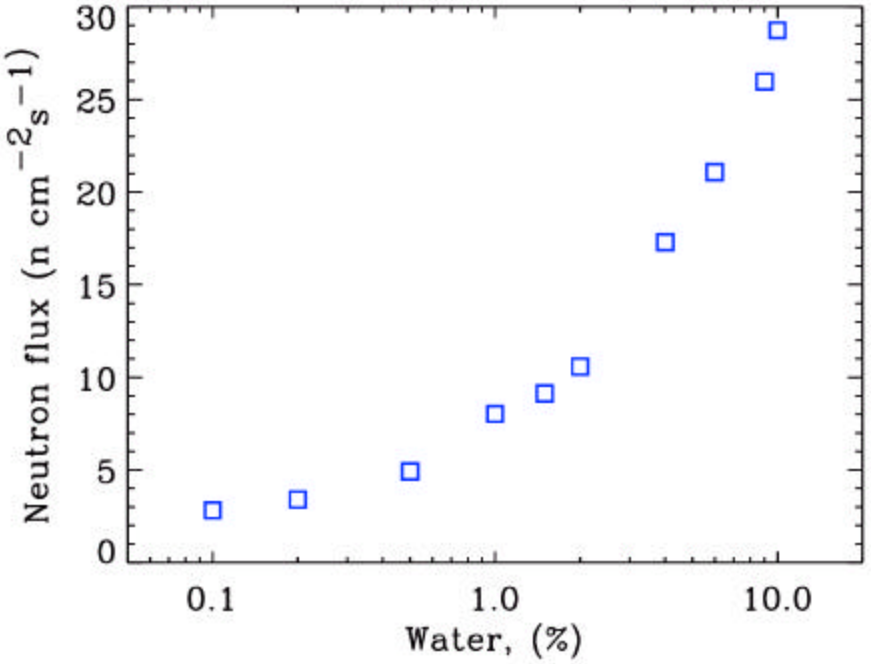


Figure 1. Numerical calculation of average thermal neutron flux from martian surface under the exposure by pulsing neutron generator with 10^7 neutrons per pulse and frequency of pulses 20 Hz.

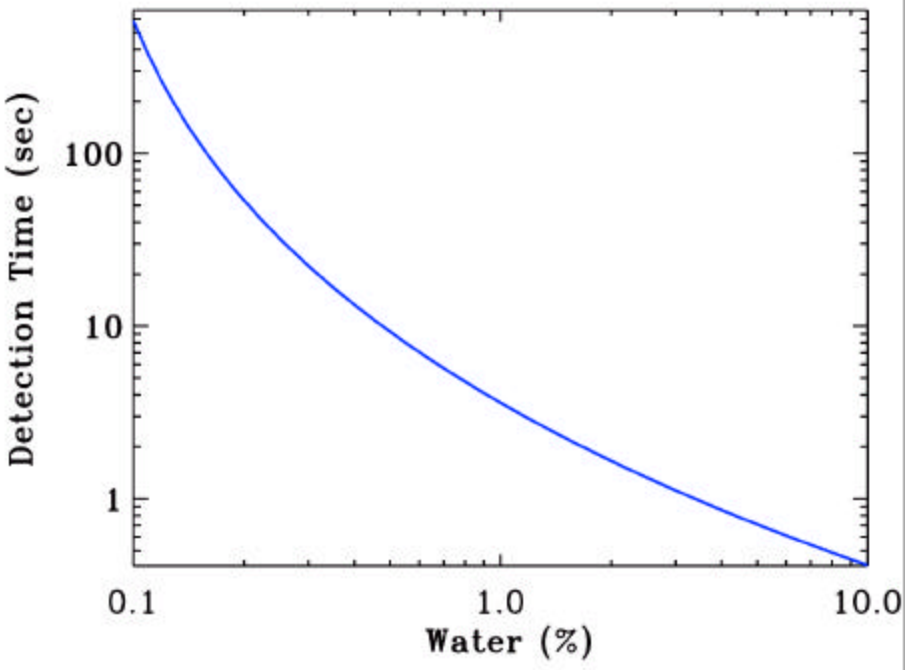
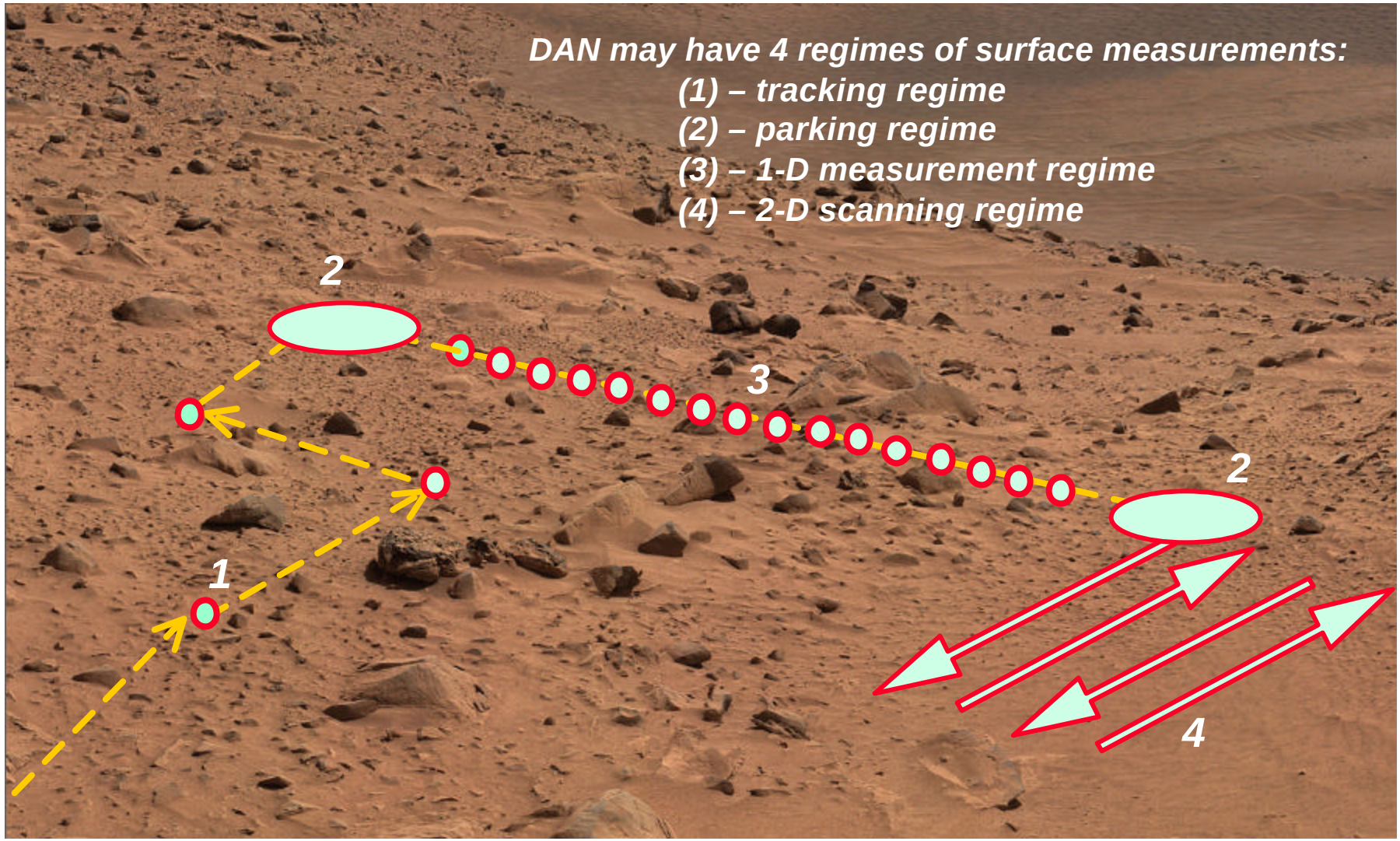


Figure 2. Detection time for efficient area of 1 cm^2 for different water content in martian subsurface at the level of 3s . Predictions are done for pulsing neutron generator with 10^7 neutron in a pulse and pulsing frequency 20 Hz).


DAN may have 4 regimes of surface measurements:
(1) – tracking regime
(2) – parking regime
(3) – 1-D measurement regime
(4) – 2-D scanning regime
2
3
2
1
4

Expected parameters of PNG for DAN:

Vacuum-based PNG with pulse intensity 10^7 neutrons/pulse
(Note: flux only when DAN NG is operating)

Neutrons energy 14 MeV

Neutron pulse duration is 1 μs

Resource of PNG is about 10^7 pulses, the total working time is

3 (0.1 Hz / ν) years

where ν is the average frequency of pulsations

DAN provides to external users digital synchro-pulse for each pulse of neutrons with 1 μs accuracy

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